

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-045523

(43)Date of publication of application : 16.02.1996

(51)Int.Cl.

H01M 8/04
H01M 8/10

(21)Application number : 06-182228

(71)Applicant : MITSUBISHI HEAVY IND LTD

(22)Date of filing : 03.08.1994

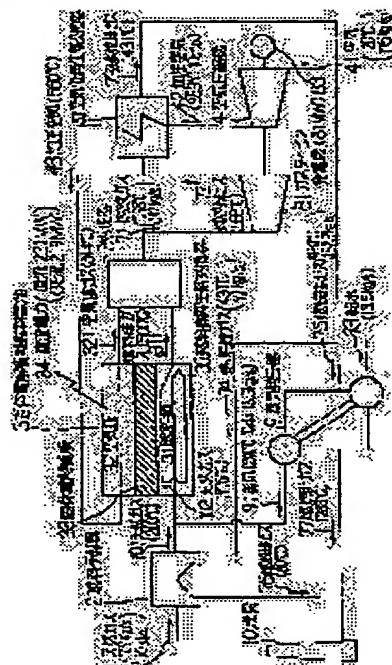
(72)Inventor : YAMAUCHI YASUHIRO
OGATA HIROSHI
KUDOME OSAO

(54) FUEL CELL/GAS TURBINE COMBINED GENERATION SYSTEM

(57)Abstract:

PURPOSE: To improve the generating efficiency of a fuel cell/gas turbine combined generation system by combining a fuel cell, a combustor, a gas turbine, an air compressor, and an air side regeneration heat exchanger, to fulfill a specific function.

CONSTITUTION: In this fuel cell/gas turbine combined generator system, a fuel cell 3 to generate a power 34 by making pressured airs 42 and 43, and a fuel, react through a solid electrolyte membrane 33; a combustor 7 to burn a fuel exhaust gas 311 exhausted from the fuel cell 3, and the air gas 321, so as to produce a combustion gas 71; a gas turbine 81 to drive a generator 83 by using the combustion gas as the operation gas; an air compressor 4 to produce the pressured airs 42 and 43; and an air side regeneration heat exchanger 51 provided between the air compressor 4 and the fuel cell 3, and to heat the pressured airs 42 and 43 by the exhaust gas of the gas turbine 81; are provided. This combined generator system improves the generating efficiency of the gas turbine, the efficiency of its bottoming cycle is improved more than a conventional system even though the generation by a steam turbine used conventionally is not carried out, and the generation efficiency as the whole system can be improved.



LEGAL STATUS

[Date of request for examination] 24.01.2000

[Date of sending the examiner's decision of rejection] 01.10.2002

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

BEST AVAILABLE COPY

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平8-45523

(43) 公開日 平成8年(1996)2月16日

(51) Int. Cl.⁶

H 0 1 M 8/04

識別記号

J

N

庁内整理番号

9444-4K

F I

技術表示箇所

8/10

審査請求 未請求 請求項の数 2 O L (全 6 頁)

(21) 出願番号 特願平6-182228

(22) 出願日 平成6年(1994)8月3日

(71) 出願人 000006208

三菱重工業株式会社

東京都千代田区丸の内二丁目5番1号

(72) 発明者 山内 康弘

長崎市深堀町5丁目717番1号 三菱重工業株式会社長崎研究所内

(72) 発明者 緒方 寛

長崎市深堀町5丁目717番1号 三菱重工業株式会社長崎研究所内

(72) 発明者 久留 長生

長崎市飽の浦町1番1号 三菱重工業株式会社長崎造船所内

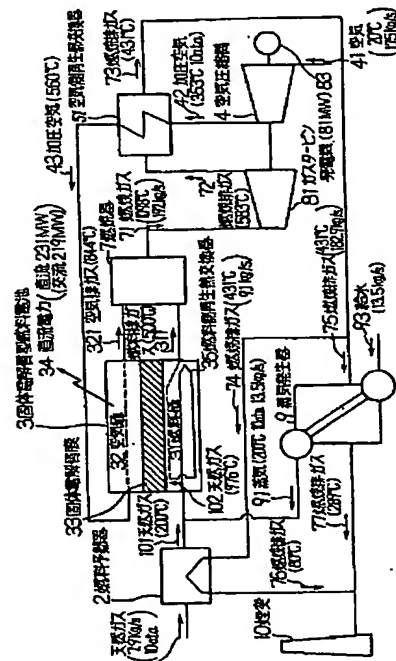
(74) 代理人 弁理士 坂間 暁 (外1名)

(54) 【発明の名称】 燃料電池／ガスタービン複合発電システム

(57) 【要約】 (修正有)

【目的】 固体電解質型燃料電池と発電機を駆動するガスタービンとを組合せて発電を行い、発電効率を向上させる。

【構成】 加圧空気42、43と燃料とを固体電解質膜33を介して反応させ電力34を発生する燃料電池3と、それから排出される燃料排ガス311および空気排ガス321を燃焼させ燃焼ガス71を生成する燃焼器7と、前記燃焼ガス71を作動ガスとして発電機83を駆動するガスタービン81と、前記加圧空気42、43を生成する空気圧縮機4と、それと前記燃料電池3との間に介装され前記ガスタービン81の排気で前記加圧空気42、43を加熱する空気側再熱交換器51とを具えた燃料電池／ガスタービン複合発電システム。



【特許請求の範囲】

【請求項1】 加圧空気と燃料とを固体電解質膜を介して反応させ電力を発生する燃料電池と、前記燃料電池から排出される燃料排ガスおよび空気排ガスを燃焼させ燃焼ガスを生成する燃焼器と、前記燃焼ガスを作動ガスとして発電機を駆動するガスタービンと、前記加圧空気を生成する空気圧縮機と、前記空気圧縮機と前記燃料電池との間に介装され前記ガスタービンの排気で前記加圧空気を加熱する空気側再生熱交換器とを具えたことを特徴とする燃料電池／ガスタービン複合発電システム。

【請求項2】 前記燃料電池に設置され、供給される前記燃料を前記燃料排ガスで加熱する燃料側再生熱交換器を具えたことを特徴とする請求項1の燃料電池／ガスタービン複合発電システム。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、固体電解質型燃料電池と発電機を駆動するガスタービンとを組合せて発電を行い、発電効率を向上させた燃料電池／ガスタービン複合発電システムに関する。

【0002】

【従来の技術】固体電解質型燃料電池は、800から1000℃の温度で作動するセラミックスで構成された燃料電池である。このような、固体電解質型燃料電池（以下単に燃料電池という）は作動温度が高いため、燃料電池から排出される空気排ガス、および燃料排ガス温度は高温となり、これらの排ガス熱をガスタービン、蒸気タービンなどのボトムリングサイクルで回収して発電することによって、高い発電効率を得られる利点を有するものである。

【0003】また、これらの燃料電池では、燃料極にニッケルを用いることにより、燃料として直接メタンなどの炭化水素と水蒸気を供給することで、燃料電池の内部で水蒸気改質反応を起こして水素、一酸化炭素を発生させ、これを燃料として用いるようにした、いわゆる内部改質を行うことも可能である。改質反応は吸熱反応であるために、燃料電池で発生した熱を吸熱して、燃料の発熱量を増加させることができるので、これによっても発電効率を向上させることができる。

【0004】図2は、天然ガスを燃料電池の燃料として使用し、燃料電池から排出される高温の排ガスの熱をガスタービン、蒸気タービンからなるボトムリングサイクルで回収し、高い発電効率を得られるようにした、従来の燃料電池、ガスタービン、および蒸気タービンからなる、複合発電システムの一例を示すブロック図である。同図において、圧力10ataの燃料としての天然ガス01は、後述する燃焼排ガス075により、燃料予熱器02で200℃まで予熱された後、天然ガス01の炭素原子等量の1.5～3.0倍のモル数の蒸気0941と混合され、燃料電池03の燃料極031側へ供給される。

【0005】また、外部から取り入れられた空気041は、後述する高圧ガスタービン081、および低圧タービン082で駆動される空気圧縮機04で、10ataの加圧空気042にされた後、一次空気予熱器05で、高圧タービン081を出た燃焼ガス072により、500℃まで加熱された後、2次空気予熱器06で、燃料電池03からの燃料排ガス0311および空気排ガス0321と、さらに熱交換して、900℃の加圧空気044となり、燃料電池03の空気極032側へ供給される。

【0006】燃料極031側へ供給された天然ガス01は、燃料電池03の燃料極031側に含まれるニッケルを触媒として、水蒸気0941と反応して、水素と一酸化炭素となる。これらの燃料と加圧空気044中の酸素が、燃料電池03の固体電解質膜033を介して反応し、直流電力034を発生させる。また、燃料電池03に供給された、天然ガス01、および加圧空気044のすべては燃料電池03で消費されず、供給された天然ガス01の15%から20%に相当する燃料排ガス0311、および燃料電池03で消費されず、燃料電池03から排出される空気排ガス0321は、前述の通り2次空気予熱器06による加圧空気043の加熱に使用された後、燃焼器07に導入され、ここで燃焼される。

【0007】燃焼後947度になった燃焼ガス071で、高圧ガスタービン081と低圧ガスタービン082を作動させ、前述の空気圧縮機04を駆動するとともに、発電機083を駆動して発電を行う。また、高圧ガスタービン081を出た燃焼ガス072は一次空気予熱器05に導入され、前述の通り加圧空気042を予熱した後、低圧ガスタービン082に導入され、低圧ガスタービン082を作動させた燃焼排ガス074の一部075が、前述の燃料予熱器02の加熱に用いられ、残り076は排ガスボイラー09で蒸気を発生させる。

【0008】排ガスボイラー09で発生した蒸気094は、1部0941が、前述した天然ガス01に混合され、内部改質用蒸気として用いられ、残りの蒸気0942は蒸気タービン091を作動させ、発電機092を駆動して発電を行う。蒸気タービン091を作動させた排気0943は復水器093で復水する。復水器093を出た復水0944は、外部から補給される給水0945と共に排ガスボイラー09に供給される。また、排ガスボイラー09から出た燃焼排ガス078は、燃料予熱器01からの燃焼排ガス077と混合した後、煙突010から大気へ放出される。この複合発電システムの発電効率は65%で、出力の内訳は固体電解質型燃料電池79%、ガスタービン19%、蒸気タービン2%である。

【0009】しかし、このような燃料電池、ガスタービン、蒸気タービンを複合した発電システムでは、次のような不具合がある。

【0010】(1) 蒸気タービンの蒸気温度が低く、発電効率が低いため、復水器からの排熱が多い。

【0011】(2) 機器の数が多くコスト増加になる。

【0012】(3) 蒸気タービンの容量に制限があり、小容量では蒸気タービンをつけることができず、その分、発電効率が悪くなる。

【0013】(4) 固体電解質型燃料電池の燃料入り口温度と、出口温度の差が大きく、燃料電池に大きな温度勾配が発生する。

【0014】

【発明が解決しようとする課題】本発明は、上述した従来の燃料電池を含む複合発電システムの不具合を解消するため、再生熱交換器の温度効率向上によって、ガスタービンにおける発電量を増加させて、上述従来発電システムの不具合の要因となっている、蒸気タービンのシステムへの採用を止めても、発電システム全体としての発電効率を損うことのない、燃料電池／ガスタービン複合発電システムを提供することを課題とする。

【0015】また、本発明は、燃料電池に大きな温度勾配を発生させることのない、燃料電池／ガスタービン複合発電システムを提供することを課題とする。

【0016】

【課題を解決するための手段】このため、本発明の燃料電池／ガスタービン複合発電システムは、次の手段とした。

【0017】(1) 固体電解質膜の両側に加圧空気と燃料とを供給し、加圧空気中の酸素イオンを固体電解質膜中に通過させ、固体電解質膜の反対側に供給された燃料と反応させて電力を発生できる、燃料電池を設けた。

【0018】(2) 燃料電池に供給された圧縮空気、および燃料のうち、燃料電池で消費されず燃料電池から排出される空気排ガス、および燃料排ガスを燃焼させて燃焼ガスを発生する燃焼器を設けた。

【0019】(3) 燃焼ガスで作動し、発電機を駆動させて発電を行うガスタービンを設けた。

【0020】(4) 外部から導入し、燃料電池に供給する加圧空気を生成する空気圧縮機を設けた。

【0021】(5) 空気圧縮機から吐出される加圧空気を、ガスタービンを作動させた燃焼排ガスで加熱する空気側再生熱交換器を設けた。

【0022】また、他の本発明の燃料電池／ガスタービン複合発電システムは、上記手段に加え、次の手段とした。

【0023】(6) 燃料電池に供給される燃料を、燃料電池内での発電時に生じる熱によって加熱された燃料排ガスで、発電時の作動温度近くまで加熱する燃料側再生熱交換器を設けた。

【0024】

【作用】本発明の燃料電池／ガスタービン複合発電システムは、上述の(1)～(5)の手段により、

(1) 空気側再生熱交換器は温度効率を向上させて熱回収を行うので、ガスタービンの発電効率が向上する。こ

れにより、従来使用されている蒸気タービンによる発電を行わなくても、ボトムリングサイクルの効率は従来システムに比べ向上し、システム全体としての発電効率を向上させることができる。

【0025】また、他の本発明の燃料電池／ガスタービン複合発電システムは、(1)に加え、上述(6)の手段により、

(2) 燃料側再生熱交換器の採用により、燃料電池に供給される燃料を予熱でき、高温にすることができるので燃料電池内の温度勾配を緩和できる。

【0026】

【実施例】以下、本発明の燃料電池／ガスタービン複合発電システムを、図面にもとずき説明する。図1は、本発明の燃料電池／ガスタービン複合発電システムの一実施例を示すブロック図である。

【0027】図に示すように、貯蔵タンクより供給された、圧力10ataの天然ガス等の燃料1は燃料予熱器2で、空気側再生熱交換器51を出た燃焼排ガス73により200度まで予熱された燃料101となり、燃料1の炭素原子等量の1.5から3倍のモル数の蒸気発生器9から供給される蒸気91と混合された後、燃料電池3の燃料極31側へ供給される。この燃料101は、燃料電池3内に設けられた燃料側再生熱交換器35で、燃料電池3内の発電時、すなわち、後述する空気極32へ供給された加圧空気43中の酸素イオン O^{2-} が、固体電解質膜33を通過して燃料極31に移動し、改質された燃料と反応して発電を行うときに発生する作動温度で1000℃にまで加熱され、しかも燃料電池3内で消費されず残った燃料、すなわち燃料排ガス311によって、976℃まで加熱された燃料102となり、燃料極31へ供給される。また、この燃料側再生熱交換器35における加熱側の燃料排ガス311は500度まで冷却される。また、燃料極31へ供給された燃料102は、燃料電池3の燃料極31に含まれるニッケルを触媒として、水蒸気と反応して水素と一酸化炭素に改質された燃料となる。

【0028】一方、外気から取り入れられた空気41は、後述するガスタービン81で駆動される空気圧縮機4で10ataに圧縮され、加圧空気42となり、温度効率90%の、ガスタービン81からの燃焼排ガス72を熱源とする、空気側再生熱交換器51で560℃まで加熱された加圧空気43となり、燃料電池3の空気極32へ供給される。

【0029】空気極32へ供給された加圧空気43中の酸素は、前述したように空気極32で電子を奪われ、酸素イオン O^{2-} となり、固体電解質膜33を通過して、燃料極31へ移動し、燃料極31へ供給され、水素と一酸化炭素に改質された燃料と反応し酸化物を生成するとともに、電子を放出する発電を行い直流電力34を発生させる。しかし、燃料極31へ供給された燃料は、すべて

燃料電池3で消費されず、15%~20%の燃料は、前述したように燃料排ガス311となり、燃料側再生熱交換器35で燃料102を加熱した後、500℃まで冷却されて燃焼器7へ流入する。

【0030】また、空気極32へ供給された加圧空気43も、すべては燃料電池3で消費されず空気排ガス321となり燃焼器7へ流入する。燃焼器7へ流入した空気排ガス321は、燃料電池3内の発電時の作動温度で844℃まで加熱されており、燃焼器7へ流入した燃料排ガス311を燃焼させ、1098℃の燃焼ガス71を発生させる。燃焼器7を出た燃焼ガス71はガスタービン81に流入し、ガスタービン81を作動させる。ガスタービン81は、前述した空気圧縮機4に軸結しており、空気圧縮機4を前述の通り駆動するとともに、発電機83とも軸結しており発電機83を駆動し発電を行う。

【0031】また、ガスタービン81を作動させた燃焼排ガス72は、空気側再生熱交換器51に流入し、ここで、前述したように、空気圧縮機4から吐出された加圧空気42を加熱した後、燃焼排ガス73の一部の燃焼排ガス74は燃料予熱器2で、前述の通り燃料1の予熱に用いられ、低温の燃焼排ガス75となって燃料予熱器2から流出する。さらに、残りの燃焼排ガス75は、蒸気発生器9へ流入し、給水93を加熱し蒸気91を発生さ*

システム	入熱
従来システム	60939kcal/s
本実施例システム	59071kcal/s

また、本実施例によれば、燃料側再生熱交換器35により、燃料101は加熱されて、燃料電池3の作動温度に近い976℃で燃料電池3に流入するので、燃料電池3に大きな温度勾配が発生することもなく、燃料電池3を長寿命化できる。

【0034】

【発明の効果】以上述べたように、本発明の燃料電池／ガスタービン複合発電システムによれば、特許請求の範囲に示す構成により、空気側再生熱交換器の温度効率を向上させて熱回収できるので、ガスタービンの発電効率が向上する。これにより、従来使用されている蒸気タービンによる発電を行わなくても、ボトムリングサイクルの効率は従来システムに比べ向上し、システム全体としての発電効率を向上させることができる。

【0035】しかも、蒸気タービン使用による種々の不具合が解消し、機器の数の少い、またコストの低い、発電システムとすることができる。

【0036】また、燃料側再生熱交換器の採用により、燃料電池に供給される燃料を作動温度近くまで予熱でき、高温にすることができるので、燃料電池内の温度勾配を緩和でき、これに付随する種々の不具合を解消できる。

【図面の簡単な説明】

【図1】本発明の燃料電池／ガスタービン複合発電シ

*せる。蒸気91を発生させた燃焼排ガス76は、前記燃料予熱器2からの燃焼排ガス75と混合した後、煙突21から大気へ放出される。また、蒸気発生器9で発生させた蒸気91は前述の通り、予熱された燃料101に混合されて、燃料極31における燃料改質に使用される。

【0032】以上、本発明の一実施例について述べたが、本実施例における発電効率は70%で、出力の内訳は、SOFC73%、ガスタービン27%である。この発電効率は、前述した従来の発電システムのものに比較し、5%向上している。すなわち、従来の発電システムに使用されている蒸気タービンを廃止することにより、また、コンデンサーからの熱損失が無くなり、燃焼排ガス76によって、大気へ放出される熱損失は増えるが、空気側再生熱交換器51の温度効率の向上で回収熱が増加し、ガスタービン81による発電量が増加するので、大気に放出されることによる熱損失の増加にも拘わらず、発電効率は前述の通り向上している。即ち、再生ガスタービンサイクルのみを、燃料電池のボトムリングサイクルとすることで、ボトムリングサイクル効率が、従来システムより上昇する。

【0033】このことは、次に示すボトムリングサイクルの入熱、出力、サイクル効率から明らかである。

出力	ボトムリングサイクル効率
15311kcal/s	25.1%
19378kcal/s	32.8%

テムの一実施例を示すブロック図、

【図2】従来の固体電解質型燃料電池複合発電システムの一例を示すブロック図である。

【符号の説明】

1, 101, 102	燃料としての天然ガス
2	燃料予熱器
3	(固体電解質型) 燃料電池
31	燃料極
32	空気極
33	固体電解質膜
34	直流電力
35	燃料側再生熱交換器
311	燃料排ガス
321	空気排ガス
4	空気圧縮機
41	空気
42, 43	加圧空気
51	空気側再生熱交換器
7	燃焼器
71	燃焼ガス
72~77	燃焼排ガス
81	ガスタービン
83	発電機
9	蒸気発生器

91
93

蒸気
給水

7

(5)

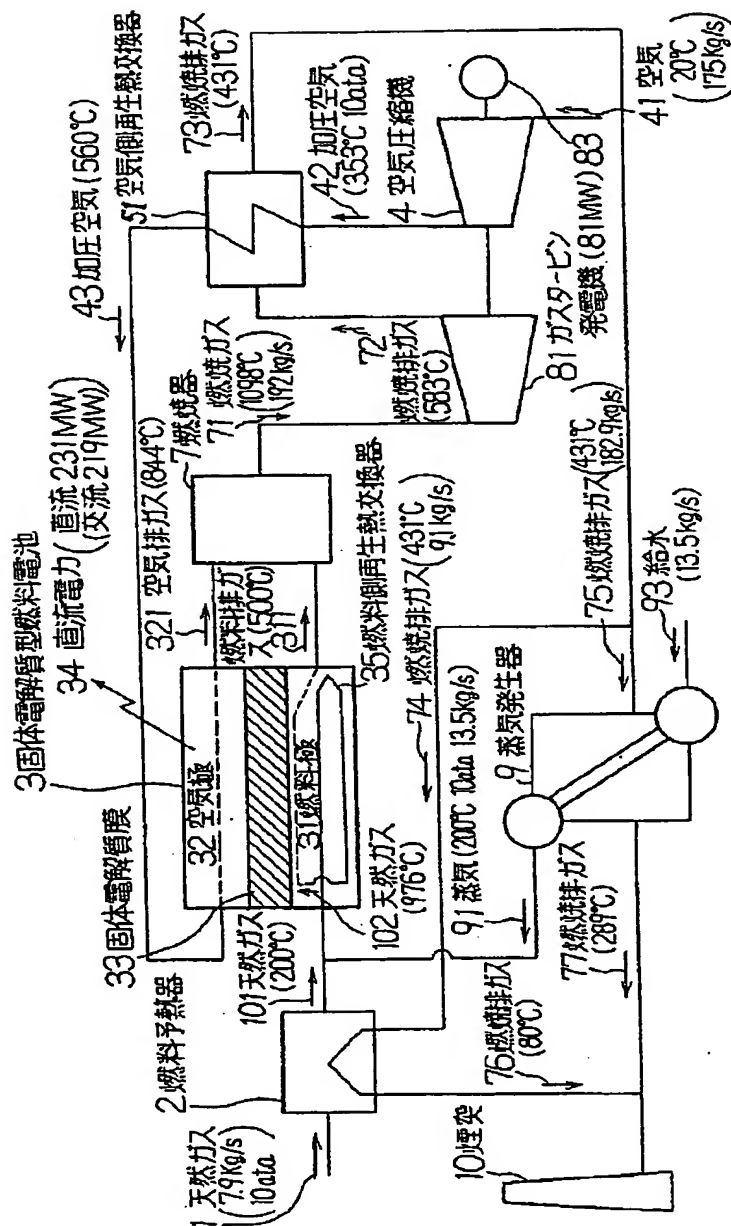
* 10
*

煙突

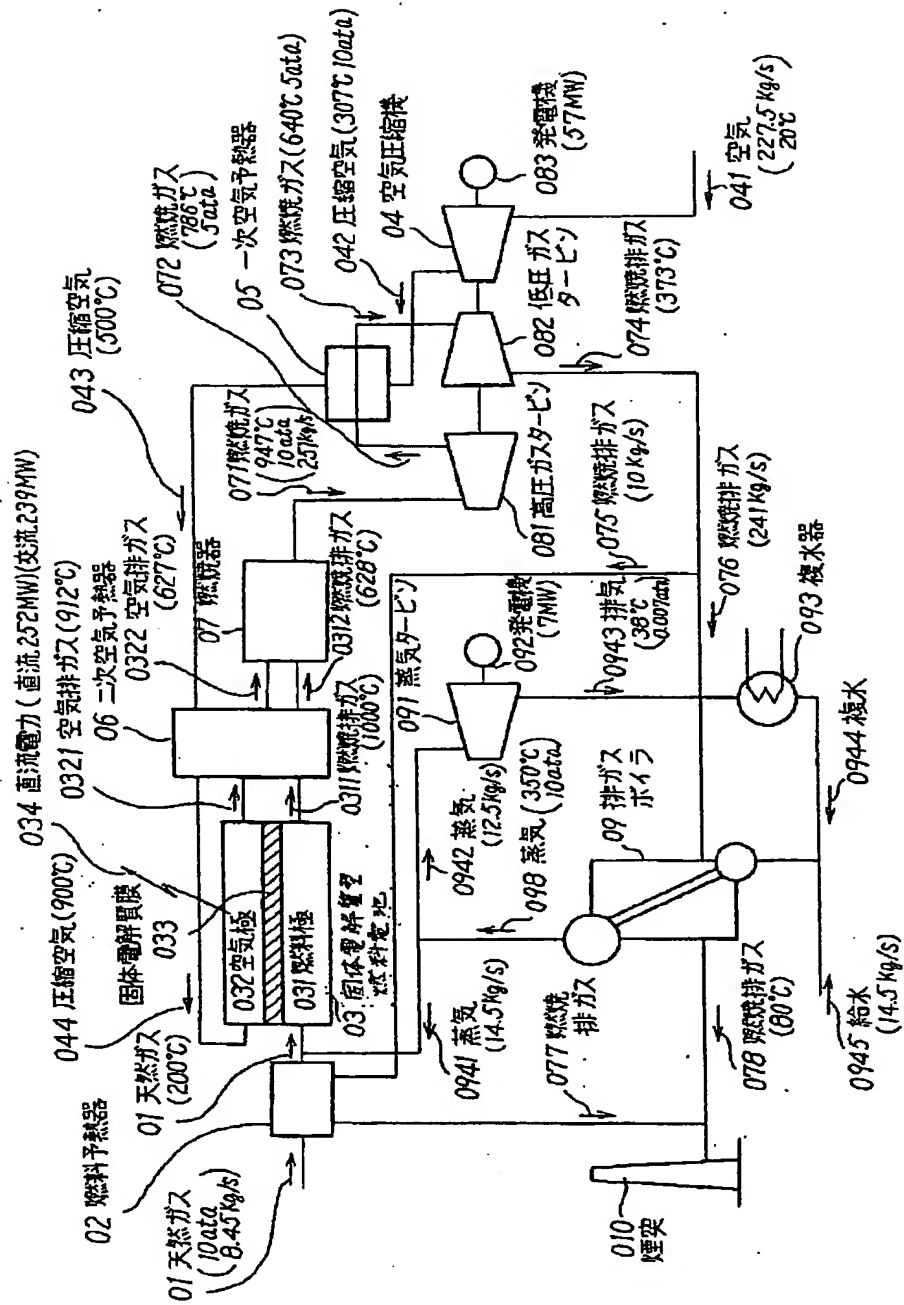
8

特開平8-45523

【図1】



【図2】



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-045523

(43)Date of publication of application : 16.02.1996

(51)Int.Cl.

H01M 8/04

H01M 8/10

(21)Application number : 06-182228

(71)Applicant : MITSUBISHI HEAVY IND LTD

(22)Date of filing : 03.08.1994

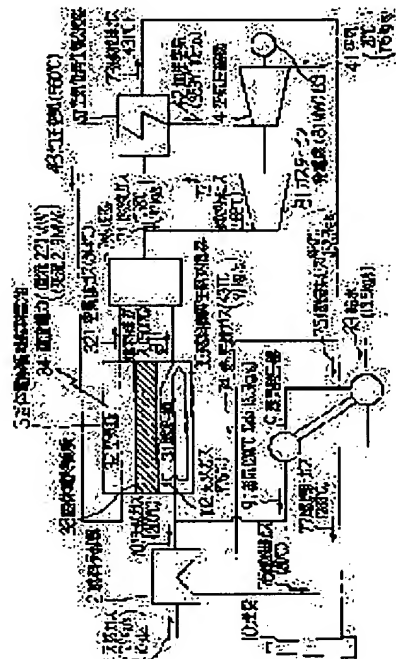
(72)Inventor : YAMAUCHI YASUHIRO
OGATA HIROSHI
KUDOME OSAO

(54) FUEL CELL/GAS TURBINE COMBINED GENERATION SYSTEM

(57)Abstract:

PURPOSE: To improve the generating efficiency of a fuel cell/gas turbine combined generation system by combining a fuel cell, a combustor, a gas turbine, an air compressor, and an air side regeneration heat exchanger, to fulfill a specific function.

CONSTITUTION: In this fuel cell/gas turbine combined generator system, a fuel cell 3 to generate a power 34 by making pressured airs 42 and 43, and a fuel, react through a solid electrolyte membrane 33; a combustor 7 to burn a fuel exhaust gas 311 exhausted from the fuel cell 3, and the air gas 321, so as to produce a combustion gas 71; a gas turbine 81 to drive a generator 83 by using the combustion gas as the operation gas; an air compressor 4 to produce the pressured airs 42 and 43; and an air side regeneration heat exchanger 51 provided between the air compressor 4 and the fuel cell 3, and to heat the pressured airs 42 and 43 by the exhaust gas of the gas turbine 81; are provided. This combined generator system improves the generating efficiency of the gas turbine, the efficiency of its bottoming cycle is improved more than a conventional system even though the generation by a steam turbine used conventionally is not carried out, and the generation efficiency as the whole system can be improved.



LEGAL STATUS

[Date of request for examination] 24.01.2000

[Date of sending the examiner's decision of rejection] 01.10.2002

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

*** NOTICES ***

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The fuel cell which application-of-pressure air and a fuel are made to react through a solid-electrolyte membrane, and generates power, The combustor which the fuel exhaust gas and air exhaust gas which are discharged from said fuel cell are burned, and generates combustion gas, The gas turbine which drives a generator by making said combustion gas into working medium, and the air compressor which generates said application-of-pressure air, The fuel cell / gas turbine combined cycle power generation system characterized by having the air side regenerated heat exchanger which is infixed between said air compressors and said fuel cells, and heats said application-of-pressure air with exhaust air of said gas turbine.

[Claim 2] The fuel cell / gas turbine combined cycle power generation system of claim 1 characterized by having the fuel side regenerated heat exchanger which is installed in said fuel cell and heats said fuel supplied with said fuel exhaust gas.

[Translation done.]

* NOTICES *

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention generates electricity combining a solid oxide fuel cell and the gas turbine which drives a generator, and relates to the fuel cell / gas turbine combined cycle power generation system which raised generation efficiency.

[0002]

[Description of the Prior Art] A solid oxide fuel cell is a fuel cell which consisted of ceramics which operates at the temperature of 800 to 1000 degrees C. It has the advantage from which high generation efficiency is acquired by such air exhaust gas discharged from a fuel cell since operating temperature of a solid oxide fuel cell (only henceforth a fuel cell) is high, and fuel exhaust gas temperature serving as an elevated temperature, and collecting and generating these exhaust gas heat in bottoming cycles, such as a gas turbine and a steam turbine.

[0003] Moreover, it is also possible by using nickel for a fuel electrode in these fuel cells to perform the so-called internal refining which causes a steam-reforming reaction inside a fuel cell, is made to generate hydrogen and a carbon monoxide, and used this as a fuel by supplying a hydrocarbon and steams, such as direct methane, as a fuel. Since a refining reaction is endothermic reaction, can carry out endoergic [of the heat generated with the fuel cell] and can make the calorific value of a fuel increase, it can raise generation efficiency also by this.

[0004] Drawing 2 is a block diagram which consists of the conventional fuel cell and gas turbine from which natural gas is used as a fuel of a fuel cell, the heat of the hot exhaust gas discharged from a fuel cell is collected from in the bottoming cycle which consists of a gas turbine and a steam turbine, and high generation efficiency was acquired, and a steam turbine and in which showing an example of a combined cycle power generation system. It sets to this drawing and is pressure 10ata. After the combustion gas 075 mentioned later preheats the natural gas 01 as a fuel to 200 degrees C with the fuel preheater 02, it is mixed with the steam 0941 1.5 to 3.0 times the number of mols of carbon atom equivalent weight of natural gas 01, and it is supplied to the fuel electrode 031 side of a fuel cell 03 by it.

[0005] Moreover, the air 041 adopted from the outside With the air compressor 04 driven by the high-pressure gas turbine 081 mentioned later and the low pressure turbine 082 10ata(s) After being made the application-of-pressure air 042, with the primary-air preheater 05 After being heated to 500 degrees C by the combustion gas 072 which came out of the high pressure turbine 081, with the secondary air preheater 06 Heat exchange is further carried out to the fuel exhaust gas 0311 from a fuel cell 03, and air exhaust gas 0321, it becomes the 900-degree C application-of-pressure air 044, and the air pole 032 side of a fuel cell 03 is supplied.

[0006] The natural gas 01 supplied to the fuel electrode 031 side reacts with a steam 0941 by making into a catalyst the nickel contained in the fuel electrode 031 side of a fuel cell 03, and serves as hydrogen and a carbon monoxide. The oxygen in such fuels and application-of-pressure air 044 reacts through the solid-electrolyte membrane 033 of a fuel cell 03, and direct current power 034 is generated. Moreover, the natural gas 01 supplied to the fuel cell 03 and all the application-of-pressure air 044 are not consumed with a fuel cell 03. The air exhaust gas 321 which is not consumed with the fuel exhaust gas 0311 which corresponds to 20% from 15% of the supplied natural gas 01, and a fuel cell 03, but is discharged from a fuel cell 03 After being used for heating of the application-of-pressure air 043 by the secondary air preheater 06 as above-mentioned, it is introduced into a combustor 07 and burns here.

[0007] While operating the high-pressure gas turbine 081 and the low voltage gas turbine 082 and driving the

above-mentioned air compressor 04 with the combustion gas 071 which became 947 degrees after combustion, it generates electricity by driving a generator 083. Moreover, after introducing into the primary-air preheater 05 the combustion gas 072 which came out of the high-pressure gas turbine 081 and preheating the application-of-pressure air 042 as above-mentioned, it is introduced into the low voltage gas turbine 082, and a part of combustion gas 074 075 which operated the low voltage gas turbine 082 is used for heating of the above-mentioned fuel preheater 02, and remainder 076 generates a steam with an exhaust gas boiler 09.

[0008] The natural gas 01 with which the one section 0941 mentioned above the steam 094 generated with the exhaust gas boiler 09 is mixed, and it is used as a steam for internal refining, and the remaining steams 0942 operate a steam turbine 091, and generate electricity by driving a generator 092. The exhaust air 0943 which operated the steam turbine 091 is condensed with a condenser 093. The condensation 0944 which came out of the condenser 093 is supplied to an exhaust gas boiler 09 with the feed water 0945 supplied from the outside. Moreover, the combustion gas 078 which came out of the exhaust gas boiler 09 is emitted to atmospheric air from a chimney stack 010, after mixing with the combustion gas 077 from the fuel preheater 01. The generation efficiency of this combined cycle power generation system is 65%, and the breakdown of an output is 2% of steam turbines 79% of solid oxide fuel cells, and gas turbine 19%.

[0009] However, there are the following nonconformities in the generation-of-electrical-energy system which compounded such a fuel cell, the gas turbine, and the steam turbine.

[0010] (1) The steam temperature of a steam turbine is low, and since generation efficiency is low, there is much exhaust heat from a condenser.

[0011] (2) Many number of devices becomes the increment in cost.

[0012] (3) The capacity of a steam turbine has a limit, by small capacity, a steam turbine cannot be attached but the part and generation efficiency worsen.

[0013] (4) The difference of the fuel inlet temperature of a solid oxide fuel cell and outlet temperature is large, and a big temperature gradient occurs in a fuel cell.

[0014]

[Problem(s) to be Solved by the Invention] Even if this invention stops the adoption to the system of a steam turbine which is made to increase the amount of generations of electrical energy in a gas turbine, and causes nonconformity of a generation-of-electrical-energy system conventionally [above-mentioned] by improvement in temperature efficiency of a regenerated heat exchanger in order to cancel the nonconformity of the combined cycle power generation system containing the conventional fuel cell mentioned above, it makes it a technical problem to offer the fuel cell / gas turbine combined cycle power generation system which does not spoil the generation efficiency as the whole generation-of-electrical-energy system.

[0015] Moreover, this invention makes it a technical problem to offer the fuel cell / gas turbine combined cycle power generation system which does not make a fuel cell generate a big temperature gradient.

[0016]

[Means for Solving the Problem] For this reason, the fuel cell / gas turbine combined cycle power generation system of this invention were made into the following means.

[0017] (1) The fuel cell which supplies application-of-pressure air and a fuel to the both sides of a solid-electrolyte membrane, is made to pass the oxygen ion in application-of-pressure air in a solid-electrolyte membrane, is made to react with the fuel supplied to the opposite hand of a solid-electrolyte membrane, and can generate power was formed.

[0018] (2) The combustor which the air exhaust gas which is not consumed with a fuel cell among the compressed air supplied to the fuel cell and a fuel, but is discharged from a fuel cell, and fuel exhaust gas are burned, and generates combustion gas was prepared.

[0019] (3) It operated with combustion gas and the gas turbine which generates electricity by making a generator drive was prepared.

[0020] (4) It introduced from the outside and the air compressor which generates the application-of-pressure air supplied to a fuel cell was formed.

[0021] (5) The air side regenerated heat exchanger which heats the application-of-pressure air breathed out from an air compressor with the combustion gas which operated the gas turbine was prepared.

[0022] Moreover, in addition to the above-mentioned means, the fuel cell / gas turbine combined cycle power generation system of other this inventions were made into the following means.

[0023] (6) The fuel side regenerated heat exchanger which heats the fuel supplied to a fuel cell to near the operating temperature at the time of a generation of electrical energy with the fuel exhaust gas heated by the heat produced at the time of a generation of electrical energy within a fuel cell was prepared.

[0024]

[Function] Since the fuel cell / gas turbine combined cycle power generation system of this invention raise temperature efficiency as for (1) air side regenerated heat exchanger and performs heat recovery with the means of above-mentioned (1) - (5), its generation efficiency of a gas turbine improves. Even if this does not perform the generation of electrical energy by the steam turbine currently used conventionally, the effectiveness of a bottoming cycle can improve compared with a system conventionally, and can raise the generation efficiency as the whole system.

[0025] Moreover, in addition to (1), the fuel cell / gas turbine combined cycle power generation system of other this inventions can preheat the fuel supplied to a fuel cell by adoption of (2) fuel side regenerated heat exchanger with the above-mentioned (6) means, and since it can be made an elevated temperature, it can ease the temperature gradient in a fuel cell.

[0026]

[Example] the fuel cell / gas turbine combined cycle power generation system of the following and this invention -- a drawing -- a basis -- **** explanation is given. Drawing 1 is the block diagram showing one example of the fuel cell / gas turbine combined cycle power generation system of this invention.

[0027] Pressure 10ata supplied from the storage tank as shown in drawing It is the fuel preheater 2, the fuels 1, such as natural gas, turn into the fuel 101 which the combustion gas 73 which came out of the air side regenerated heat exchanger 51 preheated to 200 degrees, and after being mixed with the steam 91 supplied from the steam generator [of a fuel 1] 9 of carbon atom equivalent weight of one 1.5 to 3 times the number of mols of this, they are supplied to the fuel electrode 31 side of a fuel cell 3. This fuel 101 is the fuel side regenerated heat exchanger 35 prepared in the fuel cell 3. Oxygen ion O²⁻ under time 43 of the generation of electrical energy in a fuel cell 3, i.e., the application-of-pressure air supplied to the air pole 32 mentioned later Pass a solid-electrolyte membrane 33, and move to a fuel electrode 31 and it is heated by even 1000 degrees C with the operating temperature generated when generating electricity by reacting with the fuel by which refining was carried out. And it becomes the fuel 102 heated to 976 degrees C, and a fuel electrode 31 is supplied with the fuel 311 which was not consumed within the fuel cell 3 but remained, i.e., fuel exhaust gas. Moreover, the fuel exhaust gas 311 by the side of heating in this fuel side regenerated heat exchanger 35 is cooled to 500 degrees. Moreover, the fuel 102 supplied to the fuel electrode 31 turns into a fuel by which reacted with the steam and refining was carried out to hydrogen and a carbon monoxide by making into a catalyst the nickel contained in the fuel electrode 31 of a fuel cell 3.

[0028] On the other hand, the air 41 adopted from the open air is 10ata(s) with the air compressor 4 driven by the gas turbine 81 mentioned later. It is compressed, becomes the application-of-pressure air 42, and becomes the application-of-pressure air 43 which makes a heat source the combustion gas 72 from the gas turbine 81 of 90% of temperature efficiency and which was heated to 560 degrees C by the air side regenerated heat exchanger 51, and the air pole 32 of a fuel cell 3 is supplied.

[0029] It performs the generation of electrical energy which emits an electron, and generates direct current power 34 while an electron is taken by the air pole 32 as mentioned above, and the oxygen in the application-of-pressure air 43 supplied to the air pole 32 becomes oxygen ion O²⁻, passes a solid-electrolyte membrane 33, moves to a fuel electrode 31, is supplied to a fuel electrode 31, reacts with the fuel by which refining was carried out to hydrogen and a carbon monoxide and generates an oxide. However, all the fuels supplied to the fuel electrode 31 are not consumed with a fuel cell 3, but after 15% - 20% of fuel serves as fuel exhaust gas 311 as mentioned above, and it heats a fuel 102 by the fuel side regenerated heat exchanger 35, it is cooled to 500 degrees C and it flows into a combustor 7.

[0030] Moreover, the application-of-pressure air 43 supplied to the air pole 32 is not consumed with a fuel cell 3, either, but all serve as air exhaust gas 321, and flow into a combustor 7. The air exhaust gas 321 which flowed into the combustor 7 is heated to 844 degrees C with the operating temperature at the time of the generation of electrical energy in a fuel cell 3, burns the fuel exhaust gas 311 which flowed into the combustor 7, and generates 1098-degree C combustion gas 71. The combustion gas 71 which came out of the combustor 7 flows into a gas turbine 81, and operates a gas turbine 81. KAZUTABIN 81 generates electricity by ****(ing)

the generator 83 and driving a generator 83 while it is ****(ed) to the air compressor 4 mentioned above and drives an air compressor 4 as above-mentioned.

[0031] Moreover, the combustion gas 72 which operated the gas turbine 81 flows into the air side regenerated heat exchanger 51, and as mentioned above, after heating the application-of-pressure air 42 breathed out from the air compressor 4, it is the fuel preheater 2, and some combustion gases 74 of a combustion gas 73 are used for the preheating of a fuel 1 as above-mentioned, turn into the low-temperature combustion gas 75, and flow out of the fuel preheater 2 here. Furthermore, the remaining combustion gas 75 flows into a steam generator 9, heats feed water 93, and generates a steam 91. The combustion gas 76 made to generate a steam 91 is emitted to atmospheric air from a chimney stack 21, after mixing with the combustion gas 75 from said fuel preheater 2. Moreover, as above-mentioned, the fuel 101 which it preheated is mixed and the steam 91 generated with the steam generator 9 is used for fuel refining in a fuel electrode 31.

[0032] As mentioned above, although one example of this invention was described, the generation efficiency in this example is 70%, and the breakdowns of an output are SOFC73% and gas turbine 27%. This generation efficiency is improving 5% as compared with the thing of the conventional generation-of-electrical-energy system mentioned above. namely, the thing for which the steam turbine currently used for the conventional generation-of-electrical-energy system is abolished -- moreover, although the heat loss which the heat loss from a capacitor is lost and is emitted to atmospheric air by the combustion gas 76 increases, since recovery heat increases by improvement in the temperature efficiency of the air side regenerated heat exchanger 51 and the amount of generations of electrical energy by the gas turbine 81 increases, generation efficiency is improving as above-mentioned in spite of the increment in the heat loss by being emitted to atmospheric air. That is, bottoming cycle efficiency rises from a system conventionally by making only a playback gas turbine cycle into the bottoming cycle of a fuel cell.

[0033] This is clear from the heat input of the bottoming cycle shown below, an output, and cycle efficiency.

System	Heat input	Output	Bottoming cycle efficiency
The conventional system	60939kcal/s	15311 kcal/s	25.1%
This example system	59071 kcal/s	19378kcal/s	32.8%

The reinforcement of the fuel cell 3 can be carried out without a big temperature gradient occurring in a fuel cell 3 again according to this example, 32.8%, since a fuel 101 is heated by the fuel side regenerated heat exchanger 35 and it flows into a fuel cell 3 at 976 degrees C near the operating temperature of a fuel cell 3.

[0034]

[Effect of the Invention] Since according to the fuel cell / the gas turbine combined cycle power generation system of this invention the temperature efficiency of an air side regenerated heat exchanger is raised and heat recovery can be carried out by the configuration shown in a claim as stated above, the generation efficiency of a gas turbine improves. Even if this does not perform the generation of electrical energy by the steam turbine currently used conventionally, the effectiveness of a bottoming cycle can improve compared with a system conventionally, and can raise the generation efficiency as the whole system.

[0035] And the various nonconformities by steam turbine activity can be solved, and it can consider as a generation-of-electrical-energy system with low cost that there are few devices.

[0036] Moreover, since the fuel supplied to a fuel cell can be preheated to near the operating temperature and it can be made an elevated temperature by adoption of a fuel side regenerated heat exchanger, the temperature gradient in a fuel cell can be eased and the various nonconformities which accompany this can be canceled.

[Translation done.]

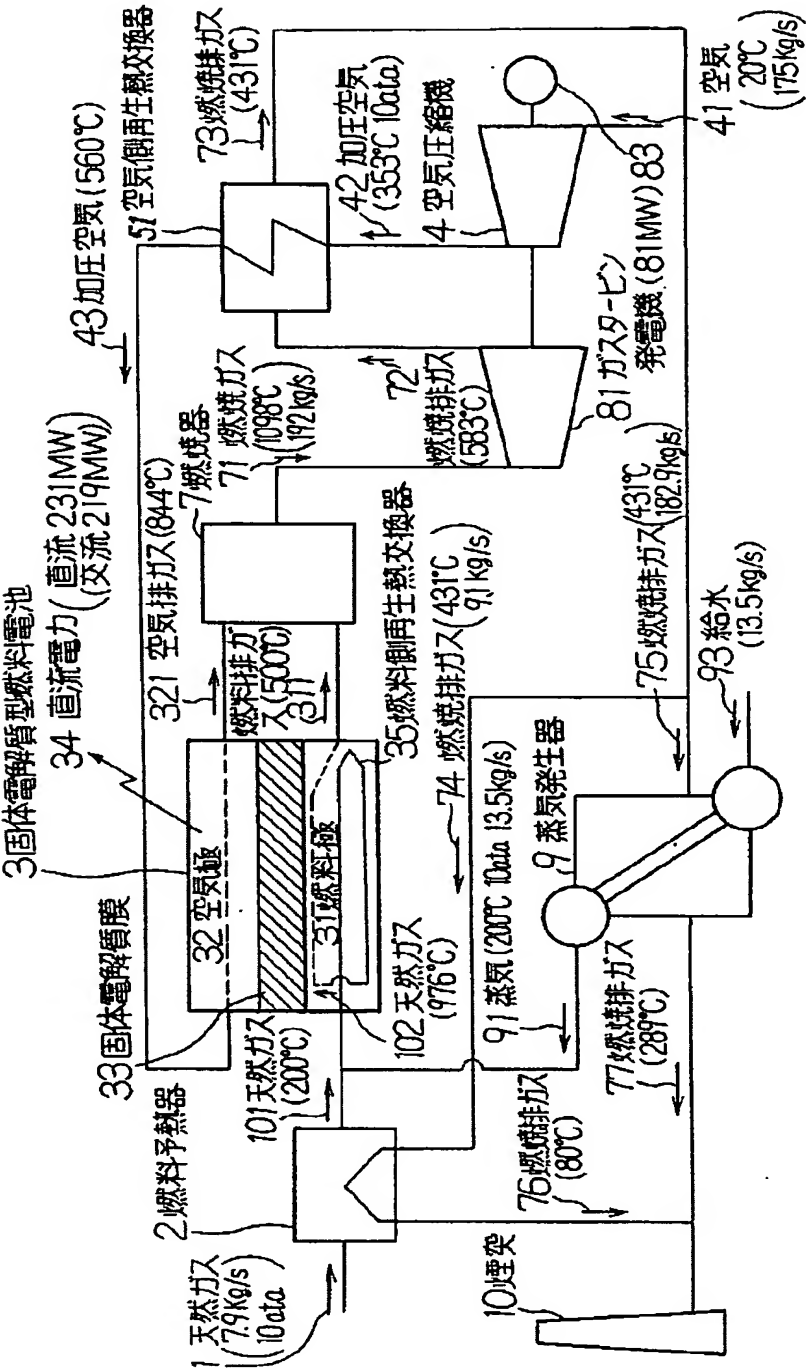
*** NOTICES ***

**JPO and NCIPi are not responsible for any
damages caused by the use of this translation.**

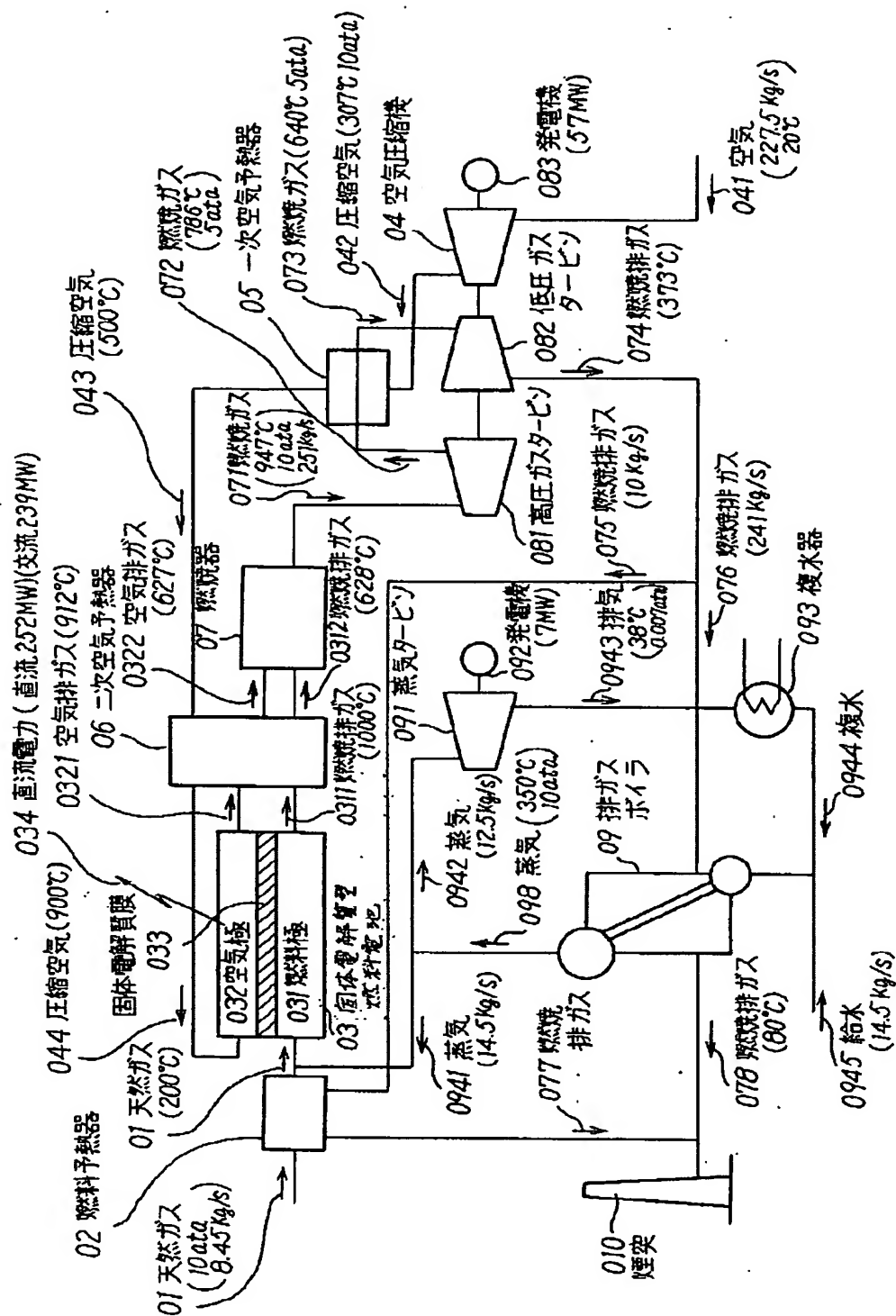
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]

This Page is inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☒ COLORED OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REPERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images
problems checked, please do not report the
problems to the IFW Image Problem Mailbox**